Convective Contamination of Mass Diffusivity Measurements with Periodic Temperature Nonuniformities

R.M. Banish [C, S]
Center for Materials Research, Department of Chemical and Materials Engineering, University of Alabama, Huntsville, AL, U.S.A.

Y.Y. Khine
Center for Materials Research, University of Alabama, Huntsville, AL, U.S.A.

Mass diffusivity determinations are typically conducted with as isothermal samples as possible. Historically, it has been considered that hot or cold "spots" along the sample were highly detrimental to these measurements. We have attempted to model the deleterious effect of localized perturbations starting with, simpler, periodic non-uniformities. In addition an magnetic field was applied to reduce the convective contamination. A two-dimensional axisymmetric model was employed. Constant, uniform, and an additional non-uniform heat fluxes are imposed along the sidewall of the cylinder while constant heat loss occurs through the top and bottom. In this model, due to a very small thermal Peclet number, convective heat transfer is neglected, and the flow is steady and inertialess. Time-dependent concentration is solved for various values of the mass Peclet number, Pem, (the ratio between the convective transport rate and the diffusive transport rate) and different magnetic field strengths represented by the Hartmann number Ha. Diffusivities are obtained using the same algorithm used to extract diffusivity values from the actual experimental data. The numerical results suggest that an additional periodic flux, or "hot" and "cold" spots, can significantly decrease the convective contamination in our geometry. The number of periodicity in temperature does not have a significant impact on the diffusivity results.